WHAT IS CLAIMED IS:

1. An electron-emitting device having a conical electron emitting portion made of carbon on an electrically conductive layer.

2. The electron-emitting device according to claim 1, in which an electron-emitting-portion-forming layer is formed between the electrically conductive layer and the electron emitting portion.

3. The electron-emitting device according to claim 1, in which the value of $H/(S/\pi)^{1/2}$ is 3 to 7 in which S is an area of bottom surface of the conical electron emitting portion and H is a height thereof.

4. A cold cathode field emission device comprising;

(A) a cathode electrode formed on a support member, and

(B) a conical electron emitting portion made of carbon and formed on the cathode electrode.

5. The cold cathode field emission device according to claim 4, in which a gate electrode having an opening portion is further provided, and the electron emitting portion is formed on that portion of the cathode electrode which is positioned in the bottom of the opening portion.

6. The cold cathode field emission device according to claim 4, in which an insulating layer is formed on the support member and the cathode electrode, a gate electrode is formed on the insulating layer, a second opening portion communicating with an opening portion formed in the gate electrode is formed in the insulating layer, and the electron emitting portion is exposed in the bottom of the second opening portion.

7. The cold cathode field emission device according to claim 4, in which an electron-emitting-portion-forming layer is formed between the cathode electrode and the electron emitting portion.

8. The cold cathode field emission device according to claim 7, in which a gate electrode having an opening portion is further provided, the electron-emitting-portion-forming layer is formed at least on the surface of that portion of the cathode electrode which is positioned in the bottom of the opening portion, and the electron emitting portion is formed on the electron-emitting-portion-forming layer.

9. The cold cathode field emission device according to claim 7, in which an insulating layer is formed on the support member and the cathode electrode, the gate electrode is formed on the insulating layer, a second opening portion communicating with the opening portion formed in the gate electrode is formed in the insulating layer, and the electron emitting portion is exposed in the bottom of the second opening portion.

10. The cold cathode field emission device according to claim 7, in which the electron-emitting-portion-forming layer is formed of a metal thin layer.

11. The cold cathode field emission device according to claim 10, in which the metal thin layer is composed of at least one metal selected from the group consisting of nickel, molybdenum, titanium, chromium, cobalt, tungsten, zirconium, tantalum, iron, copper, platinum, zinc, cadmium, germanium, tin, lead, bismuth, silver, gold, indium and thallium.

12. The cold cathode field emission device

according to claim 4, in which the value of $H/(S/\pi)^{1/2}$ is 3 to 7 in which S is an area of bottom surface of the conical electron emitting portion and H is a height thereof.

13. A method for producing a cold cathode field emission device, comprising the steps of;

(a) forming a cathode electrode on a support member, and

(b) selectively forming a conical electron emitting portion made of carbon on the surface of the cathode electrode.

14. The method for producing a cold cathode field emission device according to claim 13, in which said step (b) is followed by forming a gate electrode having an opening portion over the electron emitting portion.

15. The method for producing a cold cathode field emission device according to claim 13, in which the method further comprises, between said steps (a) and (b), the steps of;

forming an insulating layer on the support member and the cathode electrode,

forming a gate electrode having an opening portion on the insulating layer, and

forming, in the insulating layer, a second opening portion communicating with the opening portion formed in the gate electrode,

wherein the conical electron emitting portion made of carbon is formed on the cathode electrode positioned in the bottom of the second opening portion in the step (b).

16. The method for producing a cold cathode field emission device according to claim 13, in which said step (b) is followed by the steps of;

forming an insulating layer on the support member and the electron emitting portion,

forming a gate electrode having an opening portion on the insulating layer, and

forming, in the insulating layer, a second opening portion which communicates with the opening portion formed in the gate electrode and in a bottom of which the electron emitting portion is exposed.

17. The method for producing a cold cathode field emission device according to claim 13, in which the step of forming the conical electron emitting portion made of carbon is carried out on the basis of a plasma chemical vapor deposition method under a condition satisfying a plasma density of at least $10^{16}m^{-3}$ in a state where a bias voltage is applied to the support member.

18. The method for producing a cold cathode field emission device according to claim 17, in which the plasma CVD method is selected from an inductively coupled plasma CVD method, an electron cyclotron resonance plasma CVD method, a helicon wave plasma CVD method or a capacitively coupled plasma CVD method.

19. The method for producing a cold cathode field emission device according to claim 17, in which in the step of forming the conical electron emitting portion made of carbon, the temperature for heating the support member is set at 500 °C or lower.

20. The method for producing a cold cathode field emission device according to claim 13, in which the step of forming the conical electron emitting portion made of carbon is carried out on the basis of a plasma CVD method under a condition satisfying an electron temperature of 1 to 15 eV and an ion current density of 0.1 mA/cm^2 to 30 mA/cm^2 in a state where a bias voltage

is applied to the support member.

21. The method for producing a cold cathode field emission device according to claim 20, in which the plasma CVD method is selected from an inductively coupled plasma CVD method, an electron cyclotron resonance plasma CVD method, a helicon wave plasma CVD method or a capacitively coupled plasma CVD method.

22. The method for producing a cold cathode field emission device according to claim 20, in which in the step of forming the conical electron emitting portion made of carbon, the temperature for heating the support member is set at 500 °C or lower.

23. A method for producing a cold cathode field emission device, comprising the steps of;

(a) forming a cathode electrode on a support member,

(b) forming an electron-emitting-portion-forming layer on the cathode electrode, and

(c) forming a conical electron emitting portion made of carbon on the electron-emitting-portion-forming layer.

24. The method for producing a cold cathode field emission device according to claim 23, in which the method further comprises, between said steps (b) and (c), the step of forming a gate electrode having an opening portion above the electron-emitting-portion-forming layer,

wherein the conical electron emitting portion made of carbon is formed on the electron-emitting-portion-forming layer under the opening portion in the step (c).

25. The method for producing a cold cathode field

emission device according to claim 23, in which the method further comprises, between said steps (b) and (c), the step of;

forming an insulating layer on the support member and the electron-emitting-portion-forming layer,

forming a gate electrode having an opening portion on the insulating layer, and

forming, in the insulating layer, a second opening portion communicating with the opening portion formed in the gate electrode,

wherein the conical electron emitting portion made of carbon is formed on the electron-emitting-portion-forming layer positioned in the bottom of the second opening portion in the step (c).

26. The method for producing a cold cathode field emission device according to claim 23, in which the method comprises, between said steps (a) and (b), the steps of;

forming an insulating layer on the support member and the cathode electrode,

forming a gate electrode having an opening portion on the insulating layer, and

forming, in the insulating layer, a second opening portion communicating with the opening portion formed in the gate electrode,

wherein the electron-emitting-portion-forming layer is formed on the cathode electrode positioned in the bottom of the second opening portion in the step (b).

27. The method for producing a cold cathode field emission device according to claim 23, in which the step (c) is followed by the step of forming a gate electrode having an opening portion over the electron emitting portion.

28. The method for producing a cold cathode field

emission device according to claim 23, in which the step (c) is followed by the steps of;

forming an insulating layer on the support member and the electron emitting portion,

forming a gate electrode having an opening portion on the insulating layer, and

forming, in the insulating layer, a second opening portion which communicates with the opening portion formed in the gate electrode and in a bottom of which the electron emitting portion is exposed.

29. The method for producing a cold cathode field emission device according to claim 23, in which the step of forming the conical electron emitting portion made of carbon is carried out on the basis of a plasma CVD method under a condition satisfying a plasma density of at least $10^{16}m^{-3}$ in a state where a bias voltage is applied to the support member.

30. The method for producing a cold cathode field emission device according to claim 29, in which the plasma CVD method is selected from an inductively coupled plasma CVD method, an electron cyclotron resonance plasma CVD method, a helicon wave plasma CVD method or a capacitively coupled plasma CVD method.

31. The method for producing a cold cathode field emission device according to claim 29, in which in the step of forming the conical electron emitting portion made of carbon, the temperature for heating the support member can be set at 500 °C or lower.

32. The method for producing a cold cathode field emission device according to claim 23, in which the step of forming the conical electron emitting portion made of carbon is carried out on the basis of a plasma CVD method under a condition satisfying an electron

temperature of 1 to 15 eV and an ion current density of 0.1 mA/cm^2 to 30 mA/cm^2 in a state where a bias voltage is applied to the support member.

33. The method for producing a cold cathode field emission device according to claim 32, in which the plasma CVD method is selected from an inductively coupled plasma CVD method, an electron cyclotron resonance plasma CVD method, a helicon wave plasma CVD method or a capacitively coupled plasma CVD method.

34. The method for producing a cold cathode field emission device according to claim 32, in which in the step of forming the conical electron emitting portion made of carbon, the temperature for heating the support member can be set at 500 °C or lower.

35. The method for producing a cold cathode field emission device according to claim 23, in which the electron-emitting-portion-forming layer is formed of a metal thin layer.

36. The method for producing a cold cathode field emission device according to claim 35, in which the electron-emitting-portion-forming layer is formed by a physical vapor deposition method or a plating method.

37. The method for producing a cold cathode field emission device according to claim 35, in which the metal thin layer is composed of at least one metal selected from the group consisting of nickel, molybdenum, titanium, chromium, cobalt, tungsten, zirconium, tantalum, iron, copper, platinum, zinc, cadmium, germanium, tin, lead, bismuth, silver, gold, indium and thallium.

38. The method for producing a cold cathode field

emission device according to claim 23, in which after the formation of the electron-emitting-portion-forming layer, an oxide on the surface of the electron-emitting-portion-forming layer is removed.

39. The method for producing a cold cathode field emission device according to claim 38, in which the oxide is removed by a plasma reduction treatment or a washing treatment.

40. A cold cathode field emission display comprising a plurality of pixels,

each pixel being composed of a cold cathode field emission device formed on a support member, an anode electrode and a phosphor layer, said anode electrode and said phosphor layer being formed on a substrate to be opposed to the cold cathode field emission device,

said cold cathode field emission device comprising;

(A) a cathode electrode formed on the support member, and

(B) a conical electron emitting portion made of carbon and formed on the cathode electrode.

41. The cold cathode field emission display according to claim 40, in which the cold cathode field emission device further has a gate electrode having an opening portion, and the electron emitting portion is formed on that portion of the cathode electrode which is positioned in the bottom of the opening portion.

42. The cold cathode field emission display according to claim 40, in which an insulating layer is formed on the support member and the cathode electrode, a gate electrode is formed on the insulating layer, a second opening portion communicating with an opening

portion formed in the gate electrode is formed in the insulating layer, and the electron emitting portion is exposed in the bottom of the second opening portion.

43. The cold cathode field emission display according to claim 40, in which an electron-emitting-portion-forming layer is formed between the cathode electrode and the electron emitting portion.

44. The cold cathode field emission display according to claim 43, in which the cold cathode field emission device further has a gate electrode having an opening portion, the electron-emitting-portion-forming layer is formed at least on the surface of that portion of the cathode electrode which is positioned in the bottom of the opening portion, and the electron emitting portion is formed on the electron-emitting-portion-forming layer.

45. The cold cathode field emission display according to claim 43, in which an insulating layer is formed on the support member and the cathode electrode, the gate electrode is formed on the insulating layer, a second opening portion communicating with the opening portion formed in the gate electrode is formed in the insulating layer, and the electron emitting portion is exposed in the bottom of the second opening portion.

46. The cold cathode field emission display according to claim 43, in which the electron-emitting-portion-forming layer is formed of a metal thin layer.

47. The cold cathode field emission display according to claim 46, in which the metal thin layer is composed of at least one metal selected from the group consisting of nickel, molybdenum, titanium, chromium, cobalt, tungsten, zirconium, tantalum, iron, copper,

platinum, zinc, cadmium, germanium, tin, lead, bismuth, silver, gold, indium and thallium.

48. The cold cathode field emission display according to claim 40, in which the value of $H/(S/\pi)^{1/2}$ is 3 to 7 in which S is an area of bottom surface of the conical electron emitting portion and H is a height thereof.

49. A method for producing a cold cathode field emission display, comprising arranging a substrate having an anode electrode and a phosphor layer and a support member having a cold cathode field emission device such that the phosphor layer or the anode electrode and the cold cathode field emission device face each other and bonding the substrate and the support member in their circumferential regions,

wherein the cold cathode field emission device is formed by the steps of;

(a) forming a cathode electrode on the support member, and

(b) selectively forming a conical electron emitting portion made of carbon on the cathode electrode.

50. A method for producing a cold cathode field emission display, comprising arranging a substrate having an anode electrode and a phosphor layer and a support member having a cold cathode field emission device such that the phosphor layer or the anode electrode and the cold cathode field emission device face each other and bonding the substrate and the support member in their circumferential regions,

wherein the cold cathode field emission device is formed by the steps of;

(a) forming a cathode electrode on the support member,

(b) forming an electron-emitting-portion-forming layer on the cathode electrode, and

(c) forming a conical electron emitting portion made of carbon on the electron-emitting-portion-forming layer.

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